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Analysing Efficacy of Chemical and Mechanical Weed Control Methods to Growth and Quality Enhancement in Grapes (*Vitis vinifera*)

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Authors' contributions

This work was carried out in collaboration among all authors. Authors MPK and JR designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors RJ and CP managed the analyses of the study. Authors GS, PG and KR managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Weed management is one of major agronomic practices needed for effective growth and yield of crops. The cost effective weed management practices is required for grape production with minimum cost of cultivation. Research trials were taken to evaluate the bioefficacy and phytotoxicity of Indaziflam 500 SC in vineyards at Farmers fields of Appachipannai and Anumandampatti within the Cumbum Block, Theni district, Tamil Nadu during the *kharif and rabi* seasons of 2018 and 2019. The field experiment was conducted utilizing a randomized block design with three replications. The experiment encompasses ten (10) treatments, namely, T1 - Untreated control, T2 - Indaziflam 500 SC @ 37.5 g a.i./ha, T3 - Indaziflam 500 SC @ 50 g a.i./ha, T4 - Indaziflam 500 SC @ 62.5 g a.i./ha, T5 - Diuron 80% WP @ 1600 g a.i./ha, T6 - Manual weeding, T7 - Indaziflam 500 SC @ 62.5 g a.i./ha + Glyphosate 41% SL @ 1230 g a.i./ha, T8 - Indaziflam 500 SC @ 62.5 g a.i./ha + Glufosinate Ammonium 13.5% SL @ 500 g a.i./ha, T9 - Glyphosate 41% SL @ 1230 g a.i./ha and T10 - Glufosinate Ammonium 13.5% SL @ 500 g a.i./ha. Indaziflam 500 SC was sprayed as pre-emergence and tank mix application with post emergence herbicides in grapevine before the onset of South West Monsoon and North East Monsoon. During both study seasons, pre-emergence application of Indaziflam 500 SC @ 62.5 g a.i. ha-1 resulted in a considerably decreased number of weeds on 30, 60, 90, and 120 DAA. Throughout both seasons, the untreated control showed increased weed density at every stage of crop growth. Pre-emergence application of Indaziflam 500 SC @ 62.5 g a.i. ha^{-1} recorded significantly lower weed DMP at 90 DAA followed by pre-emergence application of Indaziflam 500 SC @ 50 g a.i./ha during both the seasons of the study and resulted in higher weed control efficiency at all stages of observation. Significantly higher grapes yield of 15.3 and 16.5 t/ha was recorded with manual weeding during *kharif* and *rabi* respectively due to weed free condition maintained during entire growth stage of the crop and it was followed by pre-emergence application of Indaziflam 500 SC @ 62.5 g a.i./ha. Pre-emergence application of Indaziflam 500 SC @ 62.5 g a.i. ha^{-1} recorded significantly higher fruit yield to the tune of 14.1 and 15.3 t/ha and observed 30 % and 34.5 % increased yield over standard check Diuron 80% WP @ 1600 g a.i./ha in grapes in first and second seasons respectively.

Keywords: Grapevine; weed density; weed DMP; WCE; fruit yield.

1. INTRODUCTION

Grape (*Vitis vinifera*) is cultivated in temperate to warm regions; however, a hot and arid climate is optimal for its growth and development. India is recognized as one of the preeminent grape-producing nations globally (Ramteke et al. 2012). In India, grapes are cultivated in an area of about 155.3 thousand hectares, and the production grapes was about 3357.7 thousand million metrictons in 2021 (Patel et al. 2024). Grapes are being cultivated in various states throughout India, with Maharashtra being the foremost grape-producing state, contributing over 80% of the total grape production in the nation, followed by Karnataka, Andhra Pradesh, Tamil Nadu, and Telangana.

The grape sector in India encounters various challenges, including pests and diseases infestation, weed management, insufficient storage facilities and high cost of transportation, poor infrastructural development with the rural areas, and market price fluctuations. Concerning weed management, weeds can compete with grapevines for water, nutrients, light, and space. A reduction in grape yield was observed to be 37 percent attributable to weed competition (Sanguankeo et al. 2009). The yield decrement associated with weeds was noted in both agricultural and horticultural crops due to competition for resources; furthermore, weeds acted as alternative hosts for insects, diseases, and nematodes, exacerbating the pest dilemma. Additionally, it has been reported that weeds introduce compounds into the soil that can adversely affect the growth of susceptible plants (Ladaniya et al. 2020 and Akata et al. 2024). To achieve a grape yield of commendable quantity and quality, appropriate weed management practices must be adhered to. Agronomic strategies such as irrigation and nutrient management also play a critical role in controlling weeds within vineyards. Chemical management of weeds has likewise been shown to enhance grape yield. Consequently, the study was embarked upon to examine the effects of different chemical weed management at different rates on weed control, growth, and fruit yield of grapes (*Vitis vinifera*).

2. MATERIALS AND METHODS

The field experimental research investigations were executed to assess the bioefficacy and phytotoxicity of Indaziflam 500 SC at vineyards in the agricultural fields of Appachipannai and Anumandampatti within the Cumbum Block, Theni district, Tamil Nadu during the *kharif and rabi* seasons of 2018 and 2019. The field experiment was conducted utilizing a randomized block design with three replications. The experiment encompasses ten (10) treatments, namely, T1 - Untreated control, T2 - Indaziflam 500 SC @ 37.5 g a.i./ha, T3 - Indaziflam 500 SC @ 50 g a.i./ha, T4 - Indaziflam 500 SC @ 62.5 g a.i./ha, T5 - Diuron 80% WP @ 1600 g a.i./ha, T6 - Manual weeding, T7 - Indaziflam 500 SC @ 62.5 g a.i./ha + Glyphosate 41% SL @ 1230 g a.i./ha, T8 - Indaziflam 500 SC @ 62.5 g a.i./ha + Glufosinate Ammonium 13.5% SL @ 500 g a.i./ha, T9 - Glyphosate 41% SL @ 1230 g a.i./ha and T10 - Glufosinate Ammonium 13.5% SL @ 500 g a.i./ha.

The grape cultivar Muscat Humburg (Panneer) was selected for the investigation in both the agricultural practitioners' fields throughout the two years of analysis. The grapevine was trained over pandal system. The farmers followed double pruning for getting higher grape yield. Experimental assessments were conducted in pre-existing grapevine orchards subsequent to pruning. Prior to the commencement of the monsoon season, early-emerging flora were manually eradicated. A pre-emergence application of Indaziflam 500 SC at varying concentrations was administered at the initiation of the South West Monsoon and North East Monsoon intervals. To maintain the area devoid of weeds for the manual weeding treatment, systematic manual weeding was executed. When the weeds reached the fourth to sixth leaf stages, a post-emergence application of Indaziflam 500 SC treatments was implemented. Spacing interval of 4 x 2 m for commercial grape varieties and 3 x 2 m for Muscat Hamburg.

As the research endeavor entailed the bioefficacy assessment of novel herbicide compounds, the physical compatibility and phytotoxicity ratings were documented. Observations regarding weed density and biomass production were conducted. Weeds were enumerated by employing a quadrate measuring 0.5 x 0.5 m, which was placed randomly within each treated plot. The cumulative number of dicotyledonous and monocotyledonous weeds present within the quadrate frame was recorded at pre-spraying, 30, 60, 90, and 120 Days After Application (DAA). The weed count per square meter was subsequently calculated. The aggregate of all weeds was noted as the total weed count per square meter. For dry biomass, the above-ground portions of the weeds within the quadrant were collected from each plot at 90 days following application. The weed samples were air-dried and subsequently oven-dried through hot air oven to a constant weight at 60 °C and dry weight being recorded. These dry weights of weeds obtained from per square meter were determined with aid of sensitive weighing balance in gram and converted to gram per square meter basis. The percentage of weed control efficacy was calculated at 30, 45, 60, 75, 90, and 120 DAA.

Weed Control Efficiency was calculated using the following formula,

$$\text{WCE} = \frac{\text{Weed DMP in control plot} - \text{Weed DMP in treated plots}}{\text{Weed DMP in control plot}} \text{x } 100$$

Fruit yield was taken during both the seasons of the trial. All the observed data were subjected to statistical analysis and observed the significance of treatments. Square root transformation was also carried out for the weed characteristics and analysed following the analysis of variance for Randomized Block Design as suggested by Gomez and Gomez 1984.

Indaziflam 500 SC is an aliphatic group of herbicides. Spacing of followed for grapevine was 3 m x 2 m. As the experimental trials were taken in already established orchard after pruning, fertilizer dose of 0.50: 0.40: 1.30 kg/vine NPK was followed. Half the dose of potash immediately after pruning and the other half after 60 days of pruning was applied. Foliar spray of 0.1% 24 boric acid + 0.2% $ZnSO_4$ + 1.0% urea twice before flowering and 10 days after first spray was followed to overcome nutrient deficiency in Muscat Hamburg. Plant protection chemicals Imidacloprid 17.8% SL 4ml/10 l, Emamectin benzoate 5 SG 4g/10 l was followed for the control of flea beetles and thrips. 60 g of carbofuran 3G or 20g of per vine a week before pruning was applied. 1% Bordeaux mixture was prepared and used for the control of powdery mildew, downy mildew and anthracnose diseases. Spraying was followed as 0.2% Potassium chloride (2 g /l) at 20th day after berry set, followed by another spray on 40th day for getting uniform ripening.

Physical compatibility was tested while preparing the stock solution of Indaziflam 500 SC either alone or in combination with post emergence herbicides Glyphosate 40% SL and Glufosinate Ammonium 13.5% SL, the observations on physical parameters like flocculation, sedimentation and separation were examined, but no such evidences were observed. Indaziflam 500 SC was completely dissolved and there was no problem while spraying.

3. RESULTS AND DISCUSSION

Phytotoxicity rating for yellowing, stunting, necrosis, epinasty and hyponasty were recorded on1st, 3rd,5th, 7th, and 10th days after application in grapes during both the seasons. No phyto toxicity symptoms were observed with the testing herbicide.

The weed flora in the experimental field during the study period consisted of grasses and broad-leaved weeds. The sedge weed population was not noticed in the experimental trials. *Cynodon dactylon, Chloris barbata* and *Dactyloctenium aegyptium* in grasses, *Commelina benghalensis Acalypha indica, Boerhavia diffusa, Digera arvensis, Euphorbia hirta* and *Trianthema portulacastrum*. *Cynodon dactylon and Commelina benghalensis, Acalypha indica* were the dominant weed species respectively recorded under grasses and broad-leaved weeds.

Weed density: Weed density was observed as species wise at pre spray, 30, 60, 90 and 120 Days After Application (DAA). Grasses and broad-leaved weeds were observed in the experimental fields during both the seasons of the study. From the beginning of the study until the fruit was harvested, no population of sedge weed was observed. Thus, observations of the density of broad-leaved and grass weeds were taken. Broad-leaved weeds were the most dominant species followed by grasses.

Applying Indaziflam 500 SC as a pre-emergence herbicide by itself or in conjunction with a post-emergence spray successfully suppressed the weeds. There were significantly less weeds overall with the manual weeding treatment (T6). Because regular human weeding kept the area free of weeds, this treatment saw a decrease in the number of weeds. At 30 DAT, pre-emergence application of Indaziflam 500 SC @ 62.5 g a.i./ha (T_4) recorded significantly lower no. of total weed population (9.1 and 9.9 No.m^{-2}) during I and II season respectively. This was followed by Indaziflam 500 SC @ 50 g a.i./ha (T_3) and Indaziflam 500 SC @ 62.5 g a.i./ha + Glufosinate Ammonium 13.5 % SL @ 500 g a.i./ha. (T_8). Similar trend of observations was recorded during 60, 90 and 120 DAA. (Table 1). Pre-emergence application of Indaziflam 500 SC @ 62.5 g a.i./ha recorded 18.8; 20.4 No.m^{-2} and 38.5; 42.0 No.m^{-2} and 44.9; 49.0 No.m^{-2} at 60, 90 and 120 DAA respectively during I and II season. (Tables 2, 3 & 4). This result is consistent with the findings of Kavitha et al. 2021 in acid lime. Mechanical weeding with the restricted use of glyphosate was recommended for management of weeds in grapevine yard (Pala 2020).

The highest total weed density was observed in untreated control (T_1) at all stages of crop growth during both the seasons. Weed density was ranged from 78.9 to 251.6 No.m^{-2} and 97 to 279.2 No.m^{-2} respectively during I and II season of the study (Tables 1, 2, 3 & 4).

Weed dry matter production: Weed dry matter was determined at 90 DAA. Significantly lower weed DMP was observed in manual weeding (T_6) treatment due to maintenance of weed free condition during the entire growth stages of crop**.** Pre-emergence application of Indaziflam 500 SC @ 62.5 g a.i./ha (T_4) recorded significantly lower weed DMP 31.3 and 32.7 g m^{-2} at 90 DAA during I and II season respectively followed by pre-emergence application of Indaziflam 500 SC @ 50 g a.i./ha. (T_3) Due to lower weed density observed in that treatment, lower weed DMP was observed. This was followed by Indaziflam 500 SC @ 50 g a.i./ha and Indaziflam 500 SC @ 62.5 g a.i./ha + Glufosinate Ammonium 13.5 % SL @ 500 g a.i./ha (T_8). (Table 5). Weed DMP observed the highest value in untreated control (T_1) during both the seasons of study. This treatment recorded weed dry matter production of 157.9 g m^{-2} and 185.1 g m^{-2} respectively during I and II seasons. (Table 5). Maximum weed density exhibited more dry matter production in untreated control (T_1). This result is in concordance with the research results of (Lisek 2014) in grapes. Highest weed biomass was recorded in unweeded control at all stages of observation due to higher total weed density as reported earlier in tomato (Bakht et al. 2014 and Arun et al. 2021.

Table 1. Influence of different weed managements on weed density (No.m^{-2}) in grapes on 30 DAA

Treatments	Weed density					
	I Season			II Season		
	Grass	BLW	Total	Grass	BLW	Total
T_1	4.90 (24)	9.54 (91.1)	10.73 (115.1)	5.11 (26.1)	10.21 (104.3)	11.41 (130.4)
T_2	2.68 (7.2)	4.61 (21.3)	5.33 (28.5)	2.80 (7.8)	4.81 (23.2)	5.57 (31.0)
T_3	2.12 (4.5)	3.09 (9.5)	3.74 (14.0)	2.21 (4.9)	3.22 (10.4)	3.91 (15.3)
T_4	1.53 (2.3)	2.59 (6.7)	3.01 (9.1)	1.60 (2.6)	2.70 (7.3)	3.14 (9.9)
T_5	2.40 (5.7)	4.80 (23.0)	5.36 (28.7)	2.5 (6.3)	5.01 (25.1)	5.60 (31.3)
T_6	0.71 (0.5)	0.71 (0.5)	1.00 (1.0)	0.74 (0.5)	0.74 (0.5)	1.04 (1.1)
T_7	2.21 (4.9)	4.65 (21.6)	5.15 (26.5)	2.30 (5.3)	4.86 (23.6)	5.38 (28.9)
T_8	2.79 (7.8)	3.59 (12.9)	4.55 (20.7)	2.91 (8.5)	3.75 (14.1)	4.75 (22.6)
T_9	2.72 (7.4)	5.54 (30.7)	6.17 (38.1)	2.84 (8.1)	5.78 (33.4)	6.44 (41.5)
T_{10}	2.74 (7.5)	5.20 (27.1)	5.88 (34.6)	2.86 (8.2)	5.43 (29.5)	6.14 (37.7)
SEd	0.0425	0.0641	0.0700	0.0249	0.0779	0.071
CD (P=0.05)	0.0893	0.1347	0.1420	0.0523	0.1636	0.149

Data in parenthesis are original values. Others are $\sqrt{(x + 0.5)}$ transformed values

Table 2. Effect of different weed managements on weed density (No.m^{-2}) in grapes on 60 DAA

Treatments	Weed density					
	I Season			II Season		
	Grass	BLW	Total	Grass	BLW	Total
T_1	6.28 (39.5)	11.30 (127.8)	12.93 (167.3)	6.56 (43.0)	12.01 (144.3)	13.68 (187.3)
T_2	3.25 (10.6)	6.02 (36.2)	6.84 (46.8)	3.40 (11.5)	6.28 (39.5)	7.14 (51.0)
T_3	2.91 (8.5)	4.11 (16.9)	5.03 (25.3)	3.04 (9.2)	4.29 (18.4)	5.26 (27.6)
T_4	2.44 (5.9)	3.58 (12.8)	4.33 (18.8)	2.54 (6.5)	3.74 (14.0)	4.52 (20.4)
T_5	3.30 (10.9)	5.86 (34.4)	6.73 (45.2)	3.44 (11.9)	6.12 (37.4)	7.02 (49.3)
T_6	0.71 (0.5)	0.71 (0.5)	1.00 (1.00)	0.74 (0.5)	0.74 (0.5)	1.04 (1.1)
T_7	3.21 (10.3)	5.71 (32.6)	6.55 (42.9)	3.35 (11.2)	5.96 (35.5)	6.84 (46.8)
T_8	3.27 (10.7)	5.08 (25.8)	6.04 (36.5)	3.41 (11.6)	5.30 (28.1)	6.31 (39.8)
T_9	3.31 (11.0)	6.38 (40.7)	7.19 (51.6)	3.46 (12.0)	6.66 (44.3)	7.50 (56.3)
T_{10}	3.37 (11.4)	6.18 (38.2)	7.04 (49.6)	3.52 (12.4)	6.46 (41.7)	7.35 (54.1)
SEd	0.039	0.061	0.065	0.039	0.050	0.055
CD (P=0.05)	0.081	0.129	0.136	0.084	0.105	0.117

Data in parenthesis are original values. Others are $\sqrt{(x + 0.5)}$ transformed values

Table 3. Effect of different weed managements on weed density ($No.m^{-2}$) in grapes on 90 DAA

Treatments	Weed density					
	I Season			II Season		
	Grass	BLW	Total	Grass	BLW	Total
T_1	6.69 (44.7)	12.74 (162.2)	14.39 (206.9)	6.98 (48.8)	13.48 (181.8)	15.18 (230.6)
T_2	3.71 (13.8)	7.21 (52)	8.11 (65.8)	3.88 (15.0)	7.53 (56.7)	8.47 (71.7)
T_3	3.31 (11)	5.57 (31.1)	6.48 (42)	3.46 (12.0)	5.82 (33.8)	6.77 (45.8)
T_4	3.07 (9.4)	5.40 (29.1)	6.21 (38.5)	3.21 (10.3)	5.63 (31.7)	6.48 (42.0)
T_5	3.63 (13.2)	7.10 (50.5)	7.98 (63.7)	3.79 (14.4)	7.42 (55.0)	8.33 (69.4)
T_6	0.71 (0.5)	0.71 (0.5)	1.00 (1.0)	0.74 (0.5)	0.74 (0.5)	1.04 (1.1)
T_7	3.70 (13.7)	6.77 (45.8)	7.71 (59.5)	3.86 (14.9)	7.07 (49.9)	8.05 (64.8)
T_8	3.73 (13.9)	6.15 (37.8)	7.19 (51.7)	3.89 (15.1)	6.42 (41.3)	7.51 (56.4)
T_9	3.63 (13.2)	8.43 (71)	9.18 (84.2)	3.79 (14.4)	8.80 (77.4)	9.58 (91.8)
T_{10}	3.59 (12.9)	8.25 (68)	9.00 (80.9)	3.75 (14.1)	8.61 (74.1)	9.39 (88.2)
SEd	0.051	0.055	0.093	1.378	0.057	0.101
CD (P=0.05)	0.102	0.115	0.195	2.895	0.120	0.213

Data in parenthesis are original values. Others are $\sqrt{(x + 0.5)}$ transformed values

Table 4. Effect of Different Weed Managements on weed density (No.m^{-2}) in grapes on 120 DAA

Treatments	Weed density					
	I Season			II Season		
	Grass	BLW	Total	Grass	BLW	Total
T_1	7.01 (49.1)	14.23 (202.5)	15.86 (251.6)	7.32 (53.5)	15.02 (225.7)	16.70 (279.2)
T_2	4.01 (16.1)	8.07 (65.1)	9.01 (81.2)	4.19 (17.6)	8.42 (71.0)	9.41 (88.5)
T_3	3.54 (12.5)	6.05 (36.6)	7.01 (49.1)	3.70 (13.7)	6.31 (39.9)	7.32 (53.5)
T_4	3.46 (11.9)	5.74 (33)	6.70 (44.9)	3.61 (13.0)	6.00 (36.0)	7.00 (49.0)
T_5	3.93 (15.4)	7.98 (63.7)	8.90 (79.2)	4.10 (16.8)	8.34 (69.5)	9.29 (86.3)
T_6	2.35 (5.5)	2.96 (8.7)	3.78 (14.3)	2.46 (6.0)	3.09 (9.5)	3.95 (15.6)
T_7	4.01 (16.1)	7.35 (54)	8.38 (70.2)	4.19 (17.6)	7.68 (58.9)	8.75 (76.5)
T_8	4.04 (16.3)	6.58 (43.3)	7.72 (59.6)	4.22 (17.8)	6.87 (47.2)	8.06 (65.0)
T_9	4.13 (17.1)	8.82 (77.8)	9.74 (94.9)	4.32 (18.6)	9.21 (84.8)	10.17 (103.4)
T_{10}	4.10 (16.8)	8.70 (75.7)	9.62 (92.5)	4.28 (18.3)	9.08 (82.5)	10.04 (100.8)
SEd	0.042	0.098	0.122	0.0277	0.086	0.094
CD (P=0.05)	0.088	0.207	0.256	0.058	0.180	0.198

Data in parenthesis are original values. Others are $\sqrt{(x + 0.5)}$ transformed values

Table 5. Effect of different weed managements on weed dry matter production (g m^{-2}) in grapes on 90 DAA

Treatments	I Season	II Season
T_1 - Untreated control	12.57 (157.9)	13.60 (185.1)
T_2 - Indaziflam 500 SC @ 37.5 g a.i./ha	7.25 (52.5)	9.08 (82.5)
T_3- Indaziflam 500 SC @ 50 g a.i./ha	5.90 (34.8)	6.28 (39.5)
T_4- Indaziflam 500 SC @ 62.5 g a.i./ha	5.60 (31.3)	5.72 (32.7)
T_5 - Diuron 80% WP @ 1600 g a.i./ha	7.98 (63.7)	8.75 (76.6)
T_6- Manual weeding	0.71 (0.5)	3.22 (10.4)
T_7- Indaziflam 500 SC @ 62.5 g a.i./ha + Glyphosate 41% SL @ 1230 g a.i./ha	8.05 (64.8)	8.29 (68.7)
T_8- Indaziflam 500 SC @ 62.5 g a.i./ha + Glufosinate Ammonium 13.5 % SL @ 500 g a.i./ha	6.28 (39.5)	6.87 (47.3)
T_9 - Glyphosate 41% SL @ 1230 g a.i./ha	9.30 (86.4)	9.79 (95.9)
T_{10} - Glufosinate Ammonium 13.5 % SL @ 500 g a.i./ha	8.84 (78.2)	9.28 (86.1)
SEd	0.092	0.112
CD (P=0.05)	0.192	0.235

Data in parenthesis are original values. Others are $\sqrt{(x + 0.5)}$ transformed values

Table 6. Effect of different weed managements on weed control efficiency (%) in grapes

Treatments	I Season							II Season						
	15 DAA	30 DAA	45 DAA	60 DAA	75 DAA	90 DAA	120 DAA	15 DAA	30 DAA	45 DAA	60 DAA	75 DAA	90 DAA	120 DAA
T_1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_2	99.25	78.74	71.51	66.76	65.92	61.83	55.45	99.30	80.02	72.92	67.70	66.97	63.26	56.52
T_3	99.25	87.67	86.01	84.86	84.10	78.66	77.94	99.30	88.41	85.61	86.44	84.69	79.18	78.56
T_4	99.25	90.78	87.84	86.83	82.05	82.33	80.15	99.30	91.33	88.45	87.32	82.60	82.76	80.71
T_5	99.25	77.25	68.09	64.56	59.00	59.64	58.59	99.30	78.62	69.67	65.89	60.26	60.78	59.59
T_6	100	99.30	100	99.57	95.08	99.68	94.38	100	99.34	89.92	99.41	95.24	99.69	94.52
T_7	99.25	79.82	70.30	71.27	62.96	62.89	58.96	99.30	81.03	71.77	72.34	64.10	63.79	60.12
T_8	99.25	82.26	77.81	75.90	74.99	74.47	73.50	99.30	83.32	78.50	76.80	75.70	75.09	74.81
T_9	99.25	66.70	65.44	54.63	49.39	48.21	45.27	99.30	68.70	67.16	56.33	50.95	49.47	46.81
T_{10}	99.25	69.13	67.98	56.78	53.02	53.51	50.49	99.30	70.99	69.57	58.40	54.47	54.63	51.88

Percent weed control efficiency will not be analysed statistically as it is calculated based on values of T1 (Untreated control). Just it is used for comparing per cent weed control by different treatments over control

Table 7. Effect of different weed managements on grapes yield (t/ha)

Treatments	I Season	II Season
T_1 - Untreated control	6.84	7.03
T_2 - Indaziflam 500 SC @ 37.5 g a.i./ha	10.43	11.12
T_3- Indaziflam 500 SC @ 50 g a.i./ha	13.42	14.08
T_4- Indaziflam 500 SC @ 62.5 g a.i./ha	14.11	15.30
T_5 - Diuron 80% WP @ 1600 g a.i./ha	10.82	11.37
T_6- Manual weeding	15.33	16.53
T_7- Indaziflam 500 SC @ 62.5 g a.i./ha + Glyphosate 41% SL @ 1230 g a.i./ha	12.86	13.35
T_8- Indaziflam 500 SC @ 62.5 g a.i./ha + Glufosinate Ammonium 13.5 % SL @ 500 g a.i./ha	11.37	12.59
T_9 - Glyphosate 41% SL @ 1230 g a.i./ha	9.88	10.73
T_{10} - Glufosinate Ammonium 13.5 % SL @ 500 g a.i./ha	10.20	11.05
SEd	0.212	0.249
CD (P=0.05)	0.448	0.522

Percent weed control efficiency: Percent Weed Control Efficiency was worked out 15, 30, 45, 60, 75, 90 and 120 DAA. (Table 6). Higher weed control efficiency was registered with manual weeding (T_6) treatment during both the years of observation due to periodical manual weeding and lesser dry matter production of weeds. This was followed by pre-emergence application of Indaziflam 500 SC @ 62.5 g a.i./ ha (T_4) recorded higher weed control efficiency at all stages of observation. This treatment recorded 99.25, 90.78, 87.84, 86.83, 82.05, 82.33 and 80.15 % respectively during 15, 30, 45, 60, 75, 90 and 120 DAA of first season. Similarly, during second season, this treatment recorded 99.30, 91.33, 88.45, 87.32, 82.60, 82.76 and 80.71 % respectively during 15, 30, 45, 60, 75, 90 and 120 DAA of second season. The result revealed that the lower no. of weed density and lower weed DMP resulted in higher weed control efficiency (Table 6). Lower weed DMP and weed density were associated with higher weed control efficiency Patel et al. 2004 in Bhendi and Pala et al. 2018 in grapevine.

Fruit yield: Manual weeding treatment (T_6) recorded significantly higher fruit yield of 15.3 and 16.5 t/ha due to weed free condition maintained during entire growth stage of the crop. There was no competition between weeds and crops due to control of weeds periodically. Pre- emergence application of Indaziflam 500 SC @ 62.5 g a.i./ha (T_4) recorded significantly higher fruit yield to the tune of 14.1 and 15.3 t/ha. This treatment recorded 30% and 34.5 % increased yield over standard check Diuron 80% WP @ 1600 g a.i./ha (T_5) (Table 7). This is mainly due to better control of weeds through higher weed control efficiency. Increase in yield in weedicidal treatments and manual weeding might be due to increase in yield components resulting from weedy check of weeds and shifting of competition of moisture and nutrients in favor of crop. Increase in crop yields with application of weedicides (herbicides) have been reported by Guerra et al. 2012 and Topcu and Congi 2017.

4. CONCLUSION

Agronomic strategies such as irrigation and nutrient management also play a critical role in controlling weeds within vineyards. Chemical management of weeds has likewise been shown to enhance grape yield. Pre-emergence application of Indaziflam 500 SC @ 62.5 g a.i./ha after pruning can be recommended for lowering the weed infestation in grape farm. The higher weed control efficiency and for getting higher grapes yield in grapevine yards with reduced cost of cultivation towards weed management.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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